Age, Time, and Cohort Effects on Functional Status and Self-Rated Health in Elderly Men

ABSTRACT

Objectives. This study investigated age-related changes in functional status and self-rated health in elderly men, taking into account changes over time and differences between birth cohorts.

Methods. The Zutphen Elderly Study is a longitudinal study of men born in the Netherlands between 1900 and 1920. Functional status and self-rated health were measured in 513 men in 1990, in 381 men in 1993, and in 340 men in 1995. Age, time, and cohort effects were analyzed in a mixed longitudinal model.

Results. Longitudinal analyses showed that during 5 years of follow-up, the proportion of men without disabilities decreased from 53% to 39%, whereas the percentage who rated themselves as healthy decreased from 50% to 35%. Cross-sectional analyses confirmed changes in functional status, suggesting an age effect. Time-series analyses confirmed changes in self-rated health, suggesting a time effect. No birth-cohort effects were found.

Conclusions. Functional status deteriorates with age, whereas self-rated health is not related to age in men aged 70 years and older. The observed 5-year decline in self-rated health seemed to be due to a secular trend. (*Am J Public Health.* 1997;87: 1620–1625)

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Introduction

Two important indicators of health status in old age are functional status and self-rated health. If functional status diminishes, one is no longer able to perform household or self-care activities independently. Self-rated health describes how a person perceives his or her own health and is an indicator of well-being or quality of life. Furthermore, both health indicators are important predictors of mortality[1-4] and use of health care services.[5-8] In general, age is a major determinant of health status. In the elderly, however, it is not clear to what extent health status changes with getting older, because the elderly are a heterogeneous group.

The literature is fairly consistent in reporting an average age-related decline in functional status and an increase in disabilities.[9-11] This decline is observed in all age groups but seems particularly strong in those aged 80 and older.[11] It is important to note that an average decline in functional status has its specific dynamics; in most studies, a large proportion of the elderly are found to remain stable in their functional status, a smaller proportion decline, and an even smaller, but not unimportant, proportion improve in functional status.[7,8,11-13]

Self-rated health is also reported to deteriorate with advancing age, with the same underlying dynamics as the deterioration of functional status,[14-16] but it is less clear whether this relationship holds into old age. Some studies have reported better health ratings among the old-old than among the young-old.[17-19] Other investigators have found no relationship between self-rated health and age in the elderly and have emphasized stability in self-rated health in this age group.[20,21] Worse self-ratings of health with age,

even after the age of 65, have also been reported.[1,22]

However, most data on age-related changes in functional status and self-rated health stem from cross-sectional studies, making it impossible to distinguish age and birth-cohort effects. In longitudinal studies on changes in health, age effects cannot be distinguished from secular trends. Birth-cohort effects are likely to occur because knowledge about health and medical care has changed rapidly in this century.[18] Older cohorts may have different interpretations of and expectations about health and health care and may therefore rate their health status differently.[23] Secular changes in self-rated health are also not unlikely. People may change their self-reported health rating because concepts of health might change over time.[24] Another reason for secular changes in subjective and objective health of the elderly may be that life expectancy is rising and more people live to old age.[16,25]

In the present study, the effect of aging on functional status and self-rated health was analyzed in a random sample of men aged 70 years and older who were followed up for 5 years. Age-related changes were disentangled from differ-

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ences between birth cohorts or changes in time by means of a mixed longitudinal model.

Methods

Study Population

The Zutphen Elderly Study is a longitudinal investigation of lifestyle, chronic diseases, and health in elderly men in the Netherlands.[26] In the spring of 1985, a random sample of all men living in Zutphen who were born between 1900 and 1920 was recruited. This resulted in a target population of 1266 men, of whom 939 (74%) participated. These 939 men formed the cohort of the Zutphen Elderly Study. In the spring of 1990, 1993, and 1995, all survivors of this cohort were contacted for reexamination (Table 1). They received a questionnaire containing questions on disabilities and self-rated health, which was filled out at home and checked by a trained research assistant. A physical performance test was also part of the reexamination. Complete data on functional status and self-rated health were obtained for 513 men in 1990, 381 men in 1993, and 340 men in 1995 (Table 1). For 269 men, data were available for all surveys.

Measurements

Functional status was measured in terms of self-reported disabilities in routine daily activities. The questionnaire consisted of 13 items adapted from the questionnaire used in a study carried out by the World Health Organization[27]; it has been described in detail in a previous publication.[28] The items were grouped along three dimensions: basic activities of daily living, mobility, and instrumental activities of daily living. We developed a hierarchical disability scale distinguishing four categories: (1) not disabled, (2) disabled in instrumental activities of daily living only, (3) disabled in mobility and instrumental activities of daily living, and (4) disabled in basic activities of daily living, mobility, and instrumental activities of daily living. Fewer than 5% of the men did not fit into this hierarchy. They were classified according to their most disabled dimension. A change in functional status was defined as a move to another category.

Self-rated health was defined by the answer to the following question: "We would like to know what you think about your health. Please check what fits best in your case. Do you feel healthy, rather

healthy, moderately healthy or not healthy?" The value of this measure as a predictor of mortality was shown in a previous study.[3]

Statistical Methods

The data were analyzed by means of the SAS statistical package, version 6.10 (SAS Institute Inc, Cary, NC). A P value of .05 or less was considered to be statistically significant. All tests were two-sided. Functional status and self-rated health were analyzed in a multiple design in which the effects of aging, secular trends, and differences between birth cohorts can be distinguished.[29] In this design, changes in health status were analyzed according to three perspectives: (1) longitudinally, by a comparison of the health status of the men between the years of the study, (2) cross-sectionally, by a comparison of the health status of different age groups within each year of study, and (3) by time series: a comparison of the health status of similar age groups between the years of the study. A different independent variable—birth cohort, time, or age—is held constant in each perspective. Cohort effects are held constant in the longitudinal analyses, time effects in the cross-sectional analyses, and age effects in the time-series analyses. If both the longitudinal and the cross-sectional findings are consistent in direction, an effect of aging is assumed to be present. Consistent findings in both the longitudinal analyses and the time series point toward a secular trend. Differences in health status between birth cohorts are considered to be present if both the cross-sectional and the time-series analyses reveal consistent findings.

Tests for trend (Mantel-Haenszel chi-squared) were performed in each analytical perspective. The longitudinal analyses were performed for the total

group (all men who participated in at least one survey) as well as for the group of men who participated in all surveys. In the time-series approach, we compared the health status of the men in 5-year age groups over a 5-year period to exclude overlap. Thus, differences in health status of the age groups 75 through 79 years, 80 through 84 years, and 85 through 89 years were tested between 1990 and 1995.

We further related the repeated measurements of functional status and self-rated health to age and time effects with models that allowed for two sources of error: (1) within subjects between occasions and (2) between subjects. Age- and time-related changes in functional status (percentage not disabled) and self-rated health (percentage healthy) were estimated from these models. Because the outcome variables were not normally distributed, the general estimation equation approach of Zeger and Liang[30] was used to model longitudinal correlated data, with an SAS macro for longitudinal data analysis (GEE, Version 2.1). This procedure has the advantage of estimating regression coefficients without making use of the variance assumption and the advantage of including complete as well as incomplete data. Our models were fitted by means of marginal models, with an identity link function and a compound symmetry covariance structure. The analyses of repeated measurements were performed for the total group and for those who participated in all three surveys. Similar repeated measurements models constructed with a random effects model by means of the SAS procedure Proc Mixed[31] yielded similar results.

Results

The population deteriorated significantly in functional status: the percentage

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TABLE 1—Participants in Each Follow-Up Survey of the Zutphen Elderly Study, 1990 through 1995

	1990	1993	1995
Invited (survivors of original cohort), no.	721	544	463
Participants, no.	560	390	343
Participation rate, %	78	72	74
No. with complete data on functional status and self-rated health (all men)	513	381	340
No. with complete data who participated in 1990, 1993, and 1995 (men who participated in all surveys)	269	269	269

Note. Participants in the study were men born in the Netherlands between 1900 and 1920.

TABLE 2—Results of Longitudinal Analyses: 5-Year Changes in Functional Status and Self-Rated Health: Zutphen Elderly Study, 1990 through 1995

	All Men			Men Who Participated in All Surveys		
	1990 (n = 513)	1993 (n = 381)	1995 (n = 340)	1990 (n = 269)	1993 (n = 269)	1995 (n = 269)
Mean age, y	75.1	77.9	79.7	74.5	77.5	79.5
Age range, y	70–89	73–92	75–94	70–89	73–92	75–94
Disabilities, %						
No disabilities	53.0	42.8	38.5*	62.1	46.1	42.4*
IADL only	31.0	36.0	33.2	29.4	37.9	34.2
Mobility and IADL	11.9	15.5	20.6	7.8	11.5	17.5
BADL, mobility, and IADL	4.1	5.8	7.7	0.7	4.5	5.9
Self-rated health, %						
Healthy	49.7	43.3	35.3*	57.2	45.0	36.8*
Rather healthy	39.0	45.1	48.8	33.8	44.6	46.8
Moderately healthy	9.9	8.7	11.8	8.6	8.6	12.3
Not healthy	1.4	2.9	4.1	0.4	1.9	4.1

Note. IADL = instrumental activities of daily living; BADL = basic activities of daily living.
*Significant trend, tested with Mantel-Haenszel chi-squared test ($P < .05$).

health over 5 years of follow-up. Changes in functional status were explained by aging of the population, whereas changes in self-rated health seemed to be due to a secular trend. We observed no differences in functional status and self-rated health in different birth cohorts.

The observed overall decline in functional status with age was the result of individual changes in functional status. We found no differences between birth cohorts and no changes in time, but the observed 5-year changes in functional status were solely the result of aging effects. Therefore, our results are comparable with those of studies that did not control for cohort and time effects. Our results on improvement and decline in functional status support these studies, which have shown a strong relationship between advancing age and increasing disability or a general decline in functioning over 2- to 6-year periods of follow-up.[7–13] Most of these studies also revealed that disability is not a stable state, because there were persons at all ages who improved in functioning.

We expected self-rated health to deteriorate with increasing age, because self-rated health is determined partly by objective health,[19,32–36] such as functional status. Age-related changes in self-rated health were, however, expected to be smaller than age-related changes in functional status, because of two different mechanisms. The first is the *reference-group theory*, according to which people rate their health relative to the health of their peers.[18,37,38] Thus, if poor health and functional disabilities are seen as the norm among the elderly, those who are functioning reasonably well will rate their health positively. The second mechanism is *adaptation* to worsening health conditions, based on an acceptance of a deterioration in one's own functional abilities.[18] The elderly may consider this deterioration a normal consequence of aging and not a symptom of disease. Borawski and colleagues showed that the older the respondents, the less likely they were to focus on physical aspects of their health.[39] Contrary to the expectation that self-rated health deteriorates with age, we observed no changes with age when differences between birth cohorts and changes in time were controlled for. Probably, after a certain age, the aforementioned mechanisms are stronger than the impact on self-rated health of a possible decline in objective health status. More research is recommended on the effects of age on the association between objective

of men who reported no disabilities decreased from 53% in 1990 to 39% in 1995 (Table 2). At the individual level, 56% did not change in functional status, 37% deteriorated, and 7% improved. The 5-year decline was stronger for the men who participated in all three surveys than for the total group, because they were initially more healthy.

In 1990, half of the men felt "healthy," while less than 2% felt "not healthy." Five years later, the percentage who felt "healthy" was reduced to 35%, and 4% felt "not healthy" (Table 2). More than half of the men did not change in self-rated health during these 5 years (54%); 36% deteriorated in self-rated health; and 10% improved. The main shift in self-rated health was from "healthy" to "rather healthy." Among those who participated in all three surveys, the decline in self-rated health was more marked than in the total group of men.

Functional status was inversely associated with age: the proportion of men without disabilities decreased with increasing age (Table 3). Cross-sectional associations between age and self-rated health were not observed in any year of the study. In the time-series perspective (Table 4), men 75 through 79 and 85 through 89 years old in 1995 perceived their health as significantly worse than men in those age groups did in 1990. Self-rated health of the men who were 80 through 84 years of age did not differ from 1990 to 1995.

Differences in functional status between the years were not significant in any age group.

In summary, for functional status and self-rated health, longitudinal changes were observed. The change in functional status was confirmed in the cross-sectional analyses, suggesting an age effect. The change in self-rated health was confirmed in the time-series analyses, suggesting a time effect.

These results were confirmed by analyses of repeated measurements. The proportion of men without disabilities decreased during the 5 years of study by 0.6% per year ($P = .37$), while the decrease with age was 3.5% per year ($P < .001$). The proportion of men who rated themselves as healthy declined by 3.3% ($P < .001$) per year from 1990 to 1995, while the decrease with age was 0.2% ($P = .56$). For those who participated in all three surveys, results were as follows: the decline in the proportion of men without disabilities was 3.5% ($P < .001$) per year of age, whereas no change over time was observed (0.5%; $P = .57$). The proportion of men who rated themselves as healthy declined by 4.1% ($P < .001$) per year over time but did not change per year of age (0.0%; $P = .97$).

Discussion

Our population of elderly men deteriorated in functional status and self-rated

TABLE 3—Results of Cross-Sectional Analyses: Age-Related Changes in Functional Status and Self-Rated Health in Each Year of Study: Zutphen Elderly Study, 1990 through 1995

	1990			1993			1995		
	Age 70–74 (n = 269)	Age 75–79 (n = 155)	Age 80–89 (n = 89)	Age 73–77 (n = 206)	Age 78–82 (n = 116)	Age 83–92 (n = 59)	Age 75–79 (n = 191)	Age 80–84 (n = 97)	Age 85–94 (n = 52)
Disabilities, %									
No disabilities	63.9	47.7	29.2*	54.9	33.6	18.6*	51.3	27.8	11.5*
IADL only	24.9	35.5	41.6	30.1	46.6	35.6	26.2	47.4	32.7
Mobility and IADL	9.7	11.6	19.1	11.6	13.8	32.2	17.8	17.5	36.5
BADL, mobility, and IADL	1.5	5.2	10.1	3.4	6.0	13.6	4.7	7.2	19.2
Self-rated health, %									
Healthy	48.0	54.8	46.1	42.2	45.7	42.4	37.2	37.1	25.0
Rather healthy	40.1	36.1	40.4	46.6	42.2	45.8	48.7	43.3	59.6
Moderately healthy	10.8	7.7	11.2	7.8	8.6	11.9	11.0	13.4	11.5
Not healthy	1.1	1.3	2.2	3.4	3.5	0.0	3.1	6.2	3.8

Note. IADL = instrumental activities of daily living; BADL = basic activities of daily living.
*Significant trend, tested with Mantel-Haenszel chi-squared test ($P < .05$).

TABLE 4—Results of Time-Series Analyses: Comparisons in Functional Status and Self-Rated Health for 5 Years within Similar Age Groups: Zutphen Elderly Study, 1990 through 1995

	Ages 75–79		Ages 80–84		Ages 85–89	
	1990 (n = 155)	1995 (n = 191)	1990 (n = 70)	1995 (n = 97)	1990 (n = 19)	1995 (n = 41)
Mean age, y	76.9	76.5	81.7	81.8	86.6	86.5
Disabilities, %						
No disabilities	47.7	51.3	31.4	27.8	21.0	12.2
IADL only	35.5	26.2	44.3	47.4	31.6	31.7
Mobility and IADL	11.6	17.8	15.7	17.5	31.6	36.6
BADL, mobility, and IADL	5.2	4.7	8.6	7.2	15.8	19.5
Self-rated health, %						
Healthy	54.8	37.2*	44.3	37.1	52.6	22.0*
Rather healthy	36.1	48.7	38.6	43.3	47.4	61.0
Moderately healthy	7.7	11.0	14.3	13.4	0.0	14.6
Not healthy	1.3	3.1	2.9	6.2	0.0	2.4

Note. IADL = instrumental activities of daily living; BADL = basic activities of daily living.
*Significantly different between years ($P < .05$).

health and self-rated health and on determinants of self-rated health in the elderly.

When interpreting age- and time-related changes in the health of the elderly, one should take into account the effects of selective dropout due to death and nonresponse. Because functional status and self-rated health are predictive of mortality,[1–4] men who did not survive until the end of the follow-up period were less healthy at baseline than those who participated in all three surveys. Men who dropped out of the study because of nonresponse also constituted a less healthy group.[40] The effects of this selective dropout are that the time-related changes in self-rated health were more marked for those who participated in all surveys

(decline of 4.1% per year) than for the total group (decline of 3.3% per year) because initial health status was better for those who participated in all surveys. Age-related changes in health status were not affected by selective dropout.

The observed 5-year decline in self-rated health seemed to be due to a secular trend. Bias due to situational factors might theoretically explain the differences in self-rated health between the study years. It has been shown that health-related questions preceding the question on self-rated health may influence the rating.[37,41] Health ratings may also be influenced by the method of administration of the questionnaire (written or oral), by the presence of others, or by other contextual

elements.[42] In our study, the question on self-rated health was positioned in the questionnaire before any other questions on health, but in 1990 the questionnaire was given to the respondents after the physical examinations, whereas in the last two surveys, the physical examinations were performed after the questionnaire was completed. It is, however, unlikely that this small difference in questionnaire administration explains the observed differences in self-rated health between the study years. The largest difference was observed between 1993 and 1995, years in which the method of administration of the questionnaire was identical.

Other possible explanations for a secular trend in self-rated health and no

trend in functional status are that some conditions that affect self-rated health more strongly than functional status have also changed. Crimmins showed that there is no reason that all aspects of health should change in the same way at the same time, since they are affected by different processes and conditions.[43] Such conditions include social relationships,[44] depression,[45] contentment,[33] and bereavement.[46] Clues for another possible explanation of a secular trend in self-rated health lie in the reference-group hypothesis: the health norms of the elderly may have changed because of the increasing attention the media pays to today's fit and active elderly. Men who feel they cannot meet this expectation perceive their health as less good. It is also possible that being a subject in a health study changes subjects' tendency to base health ratings more on objective health. Possibly, when people in the study were asked to rate their current health, they compared it with their health during the previous survey. These explanations are, however, speculative, and more research is needed on secular trends in self-rated health and on the effects that participation in a longitudinal health study has on health ratings.

Our study supports others that reveal that some individuals experience an improved functional status, but that overall, a strong age-related decline in functional status is seen in the elderly. In this population of men from 70 through 90 years of age, self-rated health was not related to age. The decline in self-rated health we observed during 5 years of follow-up seemed due to a secular trend, whereas no secular trend in functional status was observed. This secular trend in self-rated health is not easy to explain, and it suggests that time-related factors play a role. Self-rated health has been shown to be, to a greater or lesser extent, determined by objective health, and it is therefore used or recommended as an overall measure for health in some studies.[18,34] However, measurements of public health, such as calculations of healthy life expectancy, cannot be exclusively based on data on self-rated health because such estimates may underestimate the health problems in elderly populations. Our results furthermore suggest that studying time trends in self-rated health is difficult because self-rated health may be influenced by participation in a longitudinal health study or by other time-related factors. ☐

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